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## BACON'S RELATION TO MEDICINE

Lord Bacon had already climbed far up the slippery heights of place and power when he wrote, at the age of 37:

"It is a strange desire to seek power and to lose liberty: or to seek power over others and to lose power over a man's self. The rising unto place is laborious; and by pains men come to greater pains: and it is sometimes base; and by indignities men come to dignities. The standing is slippery, and the regress is either a downfall or at least an eclipse, which is a melancholy thing."

Never has there been, perhaps, a preachment more diametrically opposed to a man's practice, a mind of greater wisdom and sagacity, yet powerless, in supreme situations, to choose the simple, straight course which is the plain pathway of truth and honor. As a mere boy, Bacon revealed one ply of his character when he gained the favor of Queen Elizabeth by a deft flattery. The same boy broke open his toy drums and trumpets "to look for the sound," abandoned his games to investigate the cause of an echo, and at twelve was busy with the art of legerdemain. In the gloomy period following his downfall, Bacon lost his life from exposure to cold in the prosecution of a biological experiment. Given his genius, his strong common sense, his well-balanced mind, he would undoubtedly have made a great name as a physician.

No other Englishman, between Linacre and Harvey, did more for medicine, the object of his particular regard. The story of Bacon's life, indeed, forces upon us the conviction of Allbutt: "Francis Bacon had done better to have gone with Harvey to Padua." The rock upon which Bacon split was his legal training, to which it is only fair to add his lowered vitality, the equivalent, in the long run, of a cold heart, and his social station, which, centering upon creature comforts and worldly place, made

for the enslaved or passive mind. The rough handling dealt out to Bacon in Macaulay's well-known essay expresses the traditional Anglo-Celtic contempt for lack of pluck in a first-class situation—

> "But More of More Hall,
> with nothing at all,
> He *slew* the dragon of Wantley."

Yet, at the age of 35, Bacon incurred the lasting hatred of Elizabeth by opposing her demand for subsidies in Parliament, an action not devoid of the generosity of youth, as voicing the rights of the people. He never repeated the experiment. In 1601, he submits to be the passive agent in the betrayal and execution of Essex, his great-hearted friend, who had enriched him by the gift of an estate worth half a million in present money. In 1621, we find him disgraced and shorn of his honors as a bribe-taking statesman, in reality the helpless scapegoat of Buckingham.

Time, which effaces all things, has dealt gently with the memory of Bacon. A physician would see this friend of medicine as, first of all, a man who was all mind, of delicate health, a victim of circumstance, snatched from Cambridge at sixteen to be trained for diplomacy, forced to take up the law through loss of his inheritance, a political thinker in advance of his time, at the beck and call of tyrannous monarchs and overweening patrons, beset by enemies all his life and eventually waylaid by them, always in other people's hands, a well-born gentleman in his breeding, of expensive personal tastes, and, for that reason, perhaps, daunted by the fear of coming down in the world. A homely German proverb runs: "To be poor is tolerable: to become poor is terrible."[1] In Bacon's case, the English custom of placing children in unsuitable positions, without reference to their vocational aptitudes, was a virtual selling into slavery. As Ben Franklin observed: "A good kicking out of doors is sometimes better than all the rich uncles in the world." Bacon's uncle was no less than Burleigh, Elizabeth's great minister, who, however, disliked him and blocked his chances for preferment, while his cousin, Robert Cecil, hated him. We must judge of

[1] *Arm sein ist nicht schlimm: arm werden ist schrecklich.*

Bacon by those pathetic lines from his will, which so well illustrate the simplicity and compact brevity of his literary style: "For my name and memory, I leave it to men's charitable speeches, and to foreign nations and to the next age."

Foreign nations, as well as his own, have not failed to judge of Bacon in the light of his real genius. Apart from the idolatry of Spedding, he was admired by Leibnitz, Boerhaave, Haller, Voltaire, d'Alembert, Virchow and Pagel, as well as by Boyle, Sydenham and Pringle. Three hundred years after his death (April 9, 1926), his scientific reputation has taken on new aspects and requires new appraisals. This has been recently attempted by two eminent medical historians, Dr. Charles Singer (London), who deals with Bacon's relation to science,[2] and Professor Max Neuburger, who analyzes his contribution to medicine.[3]

At this time of day, Bacon's relation to the science of the Renaissance is seen to be that of the forerunner rather than of the interpreter or participant. As Macaulay expounds at great length, Bacon did not invent inductive reasoning, which was known as such to Aristotle and is employed constantly by any of us in the ordinary transactions of life; nor did he elucidate it particularly well. His elaborate categories are more complex than those of the mediaeval logicians and "only tell us to do what we are all doing." In 1863, the chemist, Liebig, published a slashing critique of Bacon's contribution to inductive science.[4] He claims, not without venom, that many of Bacon's alleged experiments were lifted bodily from the works of Gilbert, Paracelsus, Drebbel and other actual workers whom he ignored or despised; that his own experiments were often fantastic and ill-considered; that his reasoning about them is sometimes delusive, confusional and that of a lawyer, bent upon deception. That Bacon lacked the training for experimentation was at once apparent to the keen judgment of William Harvey, who admired his wit and style but said that "he writes philosophy (science) like a Lord Chancellor." Singer points out that Bacon is the solitary instance of an attempted fusion of law and science. "It

[2] Singer: *The Nation*, Lond., 1926, XXXIX, 41–43.

[3] Neuburger: *Med. Life*, N. Y., 1926, XXXIII, 149–169.

[4] Liebig: Ueber Francis Bacon von Verulam, Munich, 1863.

may be," he adds, "that it was just Bacon's legal powers and legal training that shut him out from a real appreciation of the scientific process." That process Singer defines as essentially an act of judgment, comprising two distinct mental moves, viz., the making of a discovery and the demonstration of its truth. In neither of these did Bacon ever succeed. His real service to science, as Singer sets forth, lies in the clean sweep he made of Platonism and scholasticism, the influence of his writings upon the eventual foundation of the Royal Society, as acknowledged by Boyle, and upon British psychology, beginning with Locke. To these we may add the actual prediction of scientific institutions of modern type in the "House of Solomon" and the "New Atlantis." Interesting are Bacon's four categories of *"Idols"* or misleading notions, so often cited by Osler, and the basis of Harvey Robinson's thesis that all human strife and error arises from confusing opinions about things with the things themselves:

> The *Idola Tribus* (idols of the tribe) are the fallacies of the herd instinct and of mob psychology, to which all men are liable. The *Idola Specus* (idols of the cave) are the errors inherent in our own minds, our personal prejudices. The *Idola Fori* (idols of the market-place) imply our superstitious reverence for empty catchwords and clap-trap, as opposed to reality. The *Idola Theatri* (idols of the theatre) are errors springing from our tendency to swallow cut-and-dried systems of thought.

To these *Idola*, which reveal the acumen of the great lawyer, Singer adds a fifth, the *Idola Academiae* (idols of the schools), errors due to following blind, learned rules instead of forming independent judgments. "It was this fifth idol," says Singer, "that prevented Bacon from entering the promised land, of which but a Pisgah view was granted him." But here, it is interesting to note that the idea of the recent series of books bearing titles such as "Icarus or the Future of Science," or "Tantalus or the Future of Man," really derives from Bacon's "Wisdom of the Ancients." Thus Bacon's relation to science was really prophetic and (so to say) heraldic of the new order of things. There is no exaggeration in his claim that "he rang the bell which called the wits together."[5]

Macaulay praises Bacon for dispensing with the idealism of Plato, which aimed to make men wiser and more virtuous, sub-

[5] Cited by Singer.

stituting therefor the plain utilitarian motive of increasing our materal and physical well-being. Liebig denounces this Baconian materialism on the ground that the true aim of science is the discovery of truth. It is none the less a fact, however, that the utilitarian motive has actually organized and accelerated scientific research and that the physical well being of man is a very effective aim for medicine and sanitation. It is here, in fact, that we find Bacon at his best. He was keenly interested in medicine, and, in the opinion of the clinician Bamberger, "would have made a brilliant success had he devoted himself to it." Bacon was, indeed, the first to stress the needs and deficiencies of Renaissance medicine. He said of the physicians of his time that they saw things from afar off, as from a high tower, and that, like spiders, they spun webs of sophistry out of their own bowels.[6] To Bacon, the aim of medicine, is threefold, viz., to maintain health, heal disease and prolong life. This important section of the "Advancement of Learning" is analyzed at length by Professor Neuburger. In preserving health, Bacon values physical exercise above temperance, which he regards as a much overrated virtue. As to the special aim of medicine, the cure of disease, he notes that the Hippocratic plan of taking accurate case histories has fallen into disuse, so that details are passed over as commonplaces. Anatomical studies should be extended to structural variations in different people (our present doctrine of the constitution) as helping to elucidate unknown diseases; to the notation of pathological formations in dissection; to the study of the humors (secretions); to locating the "footsteps and impressions of diseases and injuries" in animals, as well as in man; and to the "dissection of beasts alive" to elucidate what goes on in life. Bacon enlarges upon the necessity of a special study of incurable diseases, the critical revision of pharmacology, remedies for the alleviation of pain, euthanasia, and the possibility of making artificial mineral waters. The third aim of medicine, the prolongation of life, is expounded in Bacon's *Historia vitae et mortis*, which, as conveyed in Neuburger's elaborate analysis, rests upon the old doctrine of vital spirits and is otherwise replete with those dietetic and therapeutic whimsies with

[6] Cited by Allbutt.

which the Renaissance literature abounds. It is a striking documentation of Bacon's lively interest in medicine. Neuburger states that it was admired by Haller and held the field, as a manual of personal hygiene, until the advent of Hufeland's *Makrobiotik*. Better evidence of Bacon's ability as a thinker on medicine is to be found in the *De augmentis* and *Sylva sylvarum*, notably his views as to the value of psychotherapy in mental disorders, the future possibilities of microscopy in examining the blood and the urine, the advantages of administering drugs in a certain order (*filum medicinale*), the use of herbs and fruits as medicines, and the means of preventing putrefaction. Here, again, Bacon is the prophet and the herald. Some of his best medical aphorisms are to be found in the *Essays*, which gave him his place as the greatest English prose writer of Shakespeare's time, and which, through their purple patches of poesy, have even given color to the theory that Bacon wrote Shakespeare's plays. But the style of the essays is, in the main, prosy compact, lawyer-like, sometimes Biblical, with knottier Latin citations than we find in Montaigne. The prudent, low-spirited Bacon as the supposititious author of *Macbeth* or the *Merry Wives* or *Midsummer Night's Dream* is as unthinkable as some musical theorist, like Richter or Jadassohn, as the composer of the *Eroica* or the Bacchanale in *Tannhäuser*. One misses the *désinvolture*, the *élan vital*, the daemonic quality of true artistic genius. Bacon excelled in Dryden's "other harmony of prose." A poet he was not.

Two of the Essays, viz., "Of Regiment of Health" and "Of Deformity" are medical in content. In the former, Bacon notes that what a man finds most suited to himself is really "the best physic to preserve health," that youth can stand many excesses, that change of regimen in age should be extensive rather than confined to one item, that to inure the body to hardship will enable it to weather diseases better. The well-known peculiarities of doctors in the Middle Ages and later are conveyed in Bacon's suggestion that it is better to employ two physicans than a doctor who plays up to the patient's whims or one who handles his case mechanically, without reference to his real condition in either event. In the essay on Deformity, Bacon elucidates the Adler inferiority-complex in the spirit of the man of affairs who

has noticed that compensatory hypertrophy of talent and effort is usual in people to whom nature has been otherwise unkind:

"Whosoever hath anything fixed in his person that doth induce contempt, hath also a perpetual spur in himself to rescue and deliver himself from scorn. Therefore all deformed persons are extreme bold, first, as in their own defence, as being exposed to scorn, but in process of time by a general habit. . . . So that upon the matter, in a great wit, deformity is an advantage to rising."

A man so sagacious and observant might obviously have made a great physician. Professor Neuburger approaches the great Lord Chancellor in this way, with the comprehending sympathy of a true medical man, and, one might almost think, with regard to the lines which Bacon wrote in the dark days before his death, in the exquisite English of which he was so assured a master:

"Death arrives gracious only to such as sit in darkness, or lie heavy burthened with grief and irons; to the poor Christian that sits bound in the galley; to despairful widows, pensive prisoners and deposed kings; to them whose fortune runs back and whose spirits mutiny; unto such death is a redeemer, and the grave a place for retiredness and rest.

These wait upon the shore of death and waft unto him to draw near, wishing above all others to see his star, that they might be led to his place; wooing the remorseless sisters to wind down the watch of their life, and to break them off before the hour. . . .

And since I must needs be dead, I require it may not be done before mine enemies, that I be not stript before I be cold; but before my friends. The night was even now; but that name is lost; it is not now late but early. Mine eyes begin to discharge their watch, and compound with this fleshly weakness for a time of perpetual rest; and I shall presently be as happy for a few hours, as I had died the first hour I was born."

F. H. Garrison

# (a) IS EPIDEMIC POLIOMYELITIS PREVENTABLE AND DOES A SPECIFIC FORM OF TREATMENT OF THE DISEASE EXIST?

HAROLD AMOSS
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(*Abstract*)

A discussion of the first question: "Is epidemic poliomyelitis preventable"—is obviously based on the existing knowledge of the pathogenesis of this disease. It is fairly definitely established that the virus gains entrance into the central nervous system by way of the nasopharynx and that the main channel of exit from the body is by the same route.

It may be assumed that in epidemics of considerable proportion such as the outbreak of 1916, the virus becomes fairly widely distributed; but the morbidity rate was low. Apparently, virus implanted in the nasopharynx does not invariably gain entrance into the central nervous system, indeed the low susceptible rate of about 1–200 shows that only in exceptional instances does poliomyelitis result. Obviously the virus thus implanted meets with some resistance.

The failure of the virus to infect is explained in part by the following observations. Experimental studies have shown that washings from the nasopharynx of some apparently healthy persons neutralize the virus. In other individuals particularly children and in adults with acute or chronic irritation of the nasopharynx, this property of the nasal washings is absent. This neutralizing power of the nasal washings may be regarded as the first line of defense against the entrance of the virus.

A second defensive mechanism is suggested by other experiments on monkeys. For example if a pledglet of cotton soaked in virus suspension is placed well back in the nares of monkeys and removed after two hours, the animals usually remain well. If however the cotton remains for twelve hours, the monkeys become infected and experimental poliomyelitis ensues. Thus the permeability of the nasal mucous membranes is increased by the long continued contact and, furthermore, irrigation of the nasopharynx with the ordinary antiseptic solutions such as $H_2O_2$,

argyrol, etc., in the strength often employed as preventive agents, increases the permeability of the mucous membranes. These experiments may have a bearing on the question of human carriage of the virus. The virus has been recovered from healthy persons who have been in intimate contact with poliomyelitic patients. Nasal washings from carriers do not neutralize the virus, and it follows that the intact mucous membranes prevent the more intimate contact of the virus with the central nervous system.

A third mechanism of defense in the monkey is rendered probable by the fact that aseptic chemical irritation of the meninges allows easy entrance of the virus from the blood stream or the nasopharynx. Thus the intraspinal injection of 2 cc. of normal horse serum into a monkey 14 hours before nasal application or intravenous injection of the virus renders the monkey susceptible to the infection. Control animals to which the virus is applied in like manner but without the previous intraspinal injection do not become infected.

We may now consider the course of events when the virus is implanted on the nasal mucous membrane.

If the first line of defense, namely, the neutralizing power of the nasal secretions, is present, the virus is destroyed. In the absence of neutralizing substances in the nasal secretions, the recipient of the virus becomes a carrier or case of the disease according to the presence or absence of the second and third mechanisms of defense.

## Prevention

In the prevention of poliomyelitis, we know of no means of predicting the presence of the third line of defense. We have made studies on the variation of the neutralizing power of the nasal washings *i.e.*, first lines of defense in the same individual over some months: during the period of a common cold the washings did not neutralize. In one period of observation extending over several weeks, the neutralizing properties were maintained when daily irrigation with warm isotonic salt solution was practiced, but three days after discontinuing the irrigation the washings no longer neutralized.

Mild antiseptics when used as a nasal wash in monkeys increase the susceptibility. One hesitates therefore to recommend this as a prophylactic measure in human beings.

### Prevention By Specific Methods

*Passive Immunization* by the injection of serum from recovered cases prevents the infection in monkeys when the virus is applied by the nasal route. Doubtless this method would be successful in man. But there are practical difficulties: (1) of obtaining sufficient serum; (2) the lack of methods for detecting the susceptible persons.

Obviously passive immunization on a large scale as a means of preventing a disease possessing such a low attack rate, is impractical. Thus to reduce the morbidity by one, about two hundred children should be immunized.

*Active Immunization* has not been applied in human beings. In monkeys our experiments analogous to the Pasteur method of preventing rabies, have failed to confer immunity. Two years ago we described an unusual strain of virus exhibiting over a series of transfers in monkeys, a mild degree of infective power and marked degree of protective effect for the monkey. In these experiments intracerebral injections were employed. In our experience, protection or active immunization arises only in those animals in which there was evidence of actual invasion of the central nervous system.

Should one consider the application of such a method in man, it should be recalled that the mortality in rabies is 100 per cent. and only 25 per cent. in poliomyelities, and there is the corresponding great difference in the attack rate in the two diseases.

### Efficiency of Quarantine Methods

The Vermont method of isolating for at least 17 days all contacts has apparently been successful in preventing local outbreaks from becoming epidemics. Yet the fact that poliomyelitis often pounces upon a few individuals in a community and then suddenly ceases, make it difficult to adjudge the efficiency of such methods. We have collected certain experimental and epidemiological facts bearing on the question of the period of infectivity and incubation period, but the time is too short to give these in detail.

As a final word I should like to call attention to the fact that we have detected the virus in nasal washings six days before onset of poliomyelitis. Thus the prevention of poliomyelitis be-

comes a problem similar to the control of measles and diphtheria, and like them may be regarded as an acute upper respiratory disease. *Prevention* then reduces itself to the same measures employed for reducing the incidence of measles and diphtheria, but on account of the *low attack rate* may be much simpler.

There are undoubtedly healthy carriers and non-paralytic cases which add to the complexity of the problem.

Whether quarantine measures are of value one cannot say—but it would be a bold public health officer who would disregard it even in the absence of assurance.

### Does a Specific Form of Treatment Exist?

Treatment with convalescent serum will be discussed by Dr. Draper. He will doubtless produce evidence to prove that convalescent serum has neutralizing power and can retard or prevent the disease in monkeys, thus theoretically there *is* a specific serum, but we have injected repeatedly over long periods sheep, calves, donkeys, horses, without producing a neutralizing serum. No antibodies are provoked without actual involvement of the central nervous system. Apparently it is impossible to produce a specific antipoliomyelitic serum in non-susceptible animals.

Reports from time to time during the past few years have been made on the use of so-called antipoliomyelitic sera. These are in reality antistreptococcic sera prepared by immunizing horse with strains of streptococci isolated from the central nervous tissues of human cases of poliomyelitis.

The relation of streptococci to poliomyelitis can be described best by reference to experimental evidence:

Streptococci have been cultivated from the human poliomyelitic central nervous tissues and from the brain and spinal cord of monkeys dead of experimental poliomyelitis. Superficial consideration of these facts may invite the inference that there is a causal relationship between these organisms and the specific disease.

Further studies however lead to entirely different conclusions:

As is well known the virus of poliomyelitis passes easily through a Berkefeld candle which withholds ordinary bacteria. The fitrate of a 5 per cent. suspension of poliomyelitic nervous tissues, even in the minute dose of .001 cc., will produce experi-

mental poliomyelitis when injected intracerebrally into monkeys. Yet aerobic and anaerobic cultures of 10 cc. of such a filtrate remain sterile.

The following experiment brings out more definitely the relation of streptococci to the poliomyelitis.

Two monkeys are injected intracerebrally with an infective dose of a Berkefeld virus filtrate, shown to be sterile by all methods of culture. In due time both monkeys show symptoms of experimental poliomyelitis and become prostrate. One monkey is etherized and the brain and cord removed aseptically. Cultures prepared in various kinds of media, aerobic and anaerobic and under partial oxygen tension remain sterile; such suspensions however are highly potent in transferring the experimental disease. The other monkey is allowed to die in the natural course of events in the experimental disease. From the brain and cord of the second monkey, streptococci are easily recovered. The human case of the disease obviously corresponds to the second monkey.

The fact that certain streptococci isolated from poliomyelitic brains may assume very minute forms simlar to the globoid bodies is not convincing proof of their specific concern in the etiology of human poliomyelitis. In fact the proof that globoid bodies constitute the etiological agent is as yet inadequate.

On such a basis one can hardly hope for specific response in poliomyelitis by treatment with antistreptococcic serum.

### Tests of the Serum for Neutralizing Power

Several years ago, we were allowed to test two different so-called antipoliomyelitic sera, one of Rosenow, the other of Nuzum & Willy. The method employed was based upon experiments carried out with human serum from convalescent cases of poliomyelitis. 2 cc. of normal horse serum were injected into the spinal canal of a normal monkey. The following morning, 50 cc. of virus filtrate were injected intravenously, and 2 cc. of human *convalescent* serum were injected intraspinally. The intraspinal injection of convalescent serum was repeated daily for two days. "The monkey remained well." When normal human serum or horse serum was injected intraspinally instead of convalescent human serum, experimental poliomyelitis resulted following the intravenous injection of the virus.

It was concluded that the convalescent serum neutralized the virus as it came through from the blood stream into more inti-

mate relation to the central nervous tissues and that serum from normal individuals or horses did not possess this power. Thus we had a simple though expensive method of testing serum. When the so-called antipoliomyelitic (antistreptococcic) serum was subjected to this test no neutralizing substances were found.

From this we concluded that the antipoliomyelitic or antistreptococcic serum of Rosenow and of Nuzum and Willy possessed no neutralizing power against poliomyelitic virus.

The monkey somwhat more resistant to the virus than human beings offers an excellent means for testing the efficiency of serum treatment and the results are no less definite than those obtained with guinea pigs in testing diphtheria antitoxin.

The evidence put forward by Rosenow is based on the treatment in human cases—a precarious foundation when more definite tests show the serum to be totally devoid of specific properties.

With our experience in experimental poliomyelitis we would *not* under any circumstances think of injecting horse serum intraspinally. We have shown repeatedly that such injections *increase* the damage and the susceptibility of monkeys. Curiously enough Rosenow now stresses the intravenous injection of his serum, shown to be *devoid* of neutralizing power. But it is not within the scope of this paper or in my experience to give any opinion on non-specific therapy in poliomyelitis.

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## (b) CAN A PRE-PARALYTIC DIAGNOSIS OF INFANTILE PARALYSIS BE MADE, AND IS THERE A SUCCESSFUL THERAPY?

GEORGE DRAPER

*(Abstract)*

It was pointed out that any effort to bring successful serum therapy to the cure of infantile paralysis depends upon the early diagnosis of the disease. Impression that the disease is primarily a paralytic one still occupies too important a position in the general understanding of the malady. Only about 15 per cent. of the total incidence of the malady develops paralysis. When paralysis has developed it is practically always too late to hope

for any specific arresting effects through serum therapy. Consequently, it is only by studying, diagnosing early and treating those individuals who make up the 85 per cent. of nonparalyzed cases that we can hope to pretect those who are destined to make up the 15 per cent. of the paralyzed. It is possible to make a diagnosis of infantile paralysis in the pre-paralytic stage. The clinical picture differs in certain definite respects from that of most other acute infections in children. There is a peculiar expression in the eyes which suggests a frightened, bewildered animal. In addition to this look, which is well-recognized by those who have seen much of the acute stage of the disease, there is a well-known alternate irritability and somnolence with a snarling whine and irritable shrug of the shoulder. The resistance to anterior flexion of the spine because of the pain produced by this manoeuvre, is also very characteristic. This resistance is the cause of erroneously called Kernig's sign in the disease. The clinical pathological findings are also very helpful, the blood count showing a definite leucocytosis of from 15,000 to 25,000, with a definite increase in the polynuclear cells. The spinal fiuid during this early stage of the disease is usually increased in quantity, somewhat increased in pressure, and contains more globulin than normal. The earliest appearance of cells is in the form of multi-lobed cells which rapidly change in a few hours to preponderating lymphocyte type.

It must not be forgotten that this disease should be classified preferably on a basis of the clinical picture of this early stage and not upon the distribution of the paralysis as has been formerly done. The disease may present a violent picture of acute infection which then subsides in one or two days with no subsequent developments. Or this preliminary phase may be followed by a few hours to a day or two apparent return to normal with a subsequent development of the meningeal aspect of the disease and paralysis, or with an almost unrecognized hour or two of slight temperature and malaise there may be immediate appearance of meningeal and paralytic symptoms.

So far as serum therapy is concerned, it can be said that the only serum which has definitely demonstrated its ability to neutralize the virus is the serum from patients who have recovered from the disease. There would seem to be enough evidence now

that if a sufficient quanitity of such recovered serum is given to patients in the pre-paralytic stage paralysis may be prevented. The serum should be given in the following way: 10 to 15 cc. intraspinally after removal of sufficient amount of spinal fluid and 50 to 100 cc. intravenously immediately afterward. These intravenous doses should be repeated within six to eight hours. The suggestion is made that it should be just as easy to secure donors for this anti-polio serum just as quickly as one secures donors for blood transfusions.

This paper does not pretend to discuss in extenso the whole matter of serum therapy, except to say that it is difficult to understand why the Rosenow serum which has been proved non-specific for the virus of poliomyelitis should be of any value.

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## (c) THE ORTHOPEDIC TREATMENT OF INFANTILE PARALYSIS

FRED H. ALBEE

The care of infantile paralysis, because of the diversity of the problems presented, tests the mechanical ingenuity of the surgeon, not only in devising proper braces which vary within very wide limits, but also in devising and selecting proper operative treatment, which affords a wide range of possibilities—from the simplest operation, such as a subcutaneous tenotomy, to the most difficult bone transplantation. Probably no other one disease requires so many different types of operations for its satisfactory treatment. Briefly they may be enumerated as follows: tendon and muscle lengthening, tendon and muscle transplantations, insertion of fascial or silk or linen ligaments, nerve transplantations, neurotization of muscles, osteotomies to overcome contractures and distortions, plastic operations on joints to improve function, stabilizing operations, such as reefing the joint capsule or overlying soft parts, or arthrodesing of the joint itself, not to mention bone transplantation to correct deformities of the joints or spinal column, and the insertion of bone grafts to stabilize joints, or prevent the telescoping of ribs into the pelvis by placing a graft between the tenth rib and the rim of the pelvis. It is not my purpose to list or to discuss all the many

possibilities, for the orthopedic surgeon must ever be prepared to meet quickly and adequately unique individual problems, and to design at the moment suitable braces and operations.

There are three types of infantile paralysis: 1, the *abortive*, comprising those cases which have never become paralyzed; 2, the *cerebral*, those in which there is involvement of the upper motor neurone with resulting spastic paralysis; 3, the *bulbospinal*—by all means the largest group—in which are placed all cases in which the lower motor neurons are affected, with resultant flaccid paralyses. (Peabody, Draper, and Dochez's classification.)

The only objection to this classification is that the groups overlap. Cases are not always true to type, nor are the types always clearly defined. A case classified as bulbospinal may have brain foci; the cerebral case may have lesions extending into the cord.

The bulbospinal type is the one with which the orthopedic surgeon is chiefly concerned. This group is characterized by flaccid motor paralysis of the muscles supplied by the spinal nerves. The lumbar enlargement of the cord is the part chiefly affected, and hence paralysis of the lower limbs is more frequent than that of the upper. Involvement of the cervical swelling of the cord occurs less often, and consequently paralysis of the upper extremities is less frequent. The degree of the paralysis cannot be estimated by the severity of its onset.

Jahss has drawn some interesting conclusions regarding the distribution of paralysis from a clinical study of 400 cases of infantile paralysis during the great epidemic of 1916 in New York City—cases observed at the clinic of the Hospital for Joint Diseases. He found that in 78 per cent. of these cases there was some involvement of the lower extremities. Thirty-eight per cent. of the patients were paralyzed in one limb only, and of these, 10 per cent. in the upper extremity, and 28 per cent. in the lower. Twenty per cent. of the cases exhibited some form of paralysis of the trunk. The cranial nerves were affected in 13 per cent. of the cases, the seventh (facial) in the majority of the cases.

*From the point of view of treatment,* the disease may be considered as having *three stages:* the acute, convalescent, and chronic. The acute stage lasts from the onset of symptoms to

the disappearance of muscular tenderness and the cessation of abnormal temperature. The convalescent stage—a purely arbitrary consideration—extends from the end of the acute stage to such time as spontaneous improvement has apparently ceased. This period usually lasts about two years, after which the condition becomes chronic.

In general, the treatment of infantile paralysis may be outlined as follows:

During the acute stage, efforts should be directed to limiting the destructive physiological process by administration of serum, by symptomatic treatment, and by prevention of faulty posture, so far as possible. This stage is rarely seen by the surgeon, but he too often sees the unfortunate results of well-intended but meddlesome treatment, which over-anxious parents often press the general practitioner to undertake during this phase; as for example, massage and electricity which, though of undoubted value later, at this stage only serve further to stimulate an already over-stimulated nervous system. It should be constantly borne in mind that one is dealing with nerve lesions, and that a quiet environment, rest, and the avoidance of all nerve stumli, such as excessive noise or light, are essential.

Joints will not become ankylosed, muscles will not hopelessly atrophy, and the patient will not become bed-ridden because he is kept quiet for a long a time as need be, to enable the damaged cord to repair without interference. This policy of doing nothing is trying to the parents who have heard of the wonders of massage and electricity, and are anxious that no time should be lost; and trying also even to the experienced surgeon when the tenderness is of unduly long duration.

The unsupported paralyzed foot in the acute stage, even if it does not become deformed, will surely lose power in the stretched muscles.

Certain deformities, most likely to occur, may be guarded against: 1—contracting the feet in plantar flexion, 2—flexion deformity of the knees, 3—flexion deformity of the hips, 4—adduction contraction of the shoulder, 5—lateral curvature of the spine.

The weight of the bed clothes, if not counteracted, often increases deformity; if the feet are in the equinus position because

of the paralysis of the anterior group, the weight of the bed clothes further exaggerates the equinus. Various means have been devised to relieve this weight. Lovett further suggested special arrangement of the bed, or the use of a special bed, to control the patient's restless movements, and support those muscles most likely to be paralyzed or overstretched, thus preventing undue deformity during this active stage.

*During the convalescent stage,* or period of spontaneous improvement, no operative procedure aiming at correction of muscle balance should be undertaken. The aim and object of treatment during this stage is to restore the greatest possible amount of efficiency to the inactive, atrophied muscles, and to prevent permanent deformity. A mental picture of the general pathologic process must be kept constantly in mind, in order that treatment may be intelligently managed. It must be remembered that the nerve centers controlling these muscles have, in a certain percentage of cases, been only temporarily inhibited in function by a hemorrhagic myelitis, with a consequent impairment of circulation and lowering of the general resistance.

The upright position of the patient should be assumed early unless involvement of spinal muscles prohibits, for recumbency favors sluggish circulation, whereas sitting and standing stimulate the muscles and nerve centers to restore "balance"; furthermore, recumbency and inaction have an untoward effect on the nervous system. A sitting posture, and as soon as is advisable, restricted walking, should be practised within two or three months after onset, with, however, great care to avoid fatigue. Outdoor air is, of course, best for the patient on general principles.

The supportive braceage or splintage treatment is always applied during the convalescent period to those cases in which it is necessary to support limbs or trunk, which would otherwise become distorted. As much care should be taken to avoid underbracing as should be exercised against over-bracing.

If the abdominal and spinal muscles are too weak to support the torso, the patient should be propped in the chair with pillows. It is important to be on the lookout for scoliosis at this time, and the patient must be put in a position to counteract its development.

Abdominal paralysis is common, but may be overlooked. The physical signs are inability of the patient to rise from recumbency to a sitting position without assistance and when upright, protrusion of the abdomen with anterior or lateral flexion of the spine. The result, if uncorrected, is eversion of the costal borders from pressure against the protuberant abdomen, and this deformity may become structural. Unilateral abdominal paralysis is less common. The abdomen should be supported in such cases by a strong corset of heavy duck or other material with inserted supporting steel which may also favor recovery of function by the abdominal muscles.

### Braces

Even if the patient is able to walk unassisted, the weakened atrophied muscles are easily fatigued and are thereby injured; hence, the minimum amount of strain should be put upon them. If the patient cannot stand or walk without aid, or does so with the production of some deformity, *e.g.*, genu recurvatum, recourse must be had to braces, because it is imperative to get the muscles into use, at the same time supporting the limb and preventing the development of deformity. However, some patients, although extensively paralyzed in the legs, can manage to get about without assistance, and in such cases, unless some specific contra-indication exists, braces should be omitted.

Braces should be made as simple and light as possible, their sole purpose being to support the limbs and prevent recurrence of the deformity. This is of the greatest importance because in the growing period of a child's life its ligaments and capsules are easily over-stretched, thus permitting irreparable damage to the joints. The brace has to be devised to meet the requirements of the individual case at hand. There is no stereotyped brace that is applicable to all cases. In these days of so many infantile paralysis cases, we feel that it devolves upon us to emphasize the rule that the architecture of the brace should be draughted by the orthopedic surgeon for each individual. The brace should be light and as simple as possible, designed to afford the support lacking because of the paralyzed muscles, and should not interfere with the action of muscles capable of functioning.

For certain types of paralysis, *e.g.*, equinus, it should be made a general rule never to trust the shoe to support the foot. Leather can never be depended upon to withstand constant strain, for wetting causes it to yield, and therefore a foot plate of metal should be fastened to the brace.

The caliper splint, so frequently worn, wears out easily and causes much trouble, and its use is not favored by the author.

The *quadriceps extensor femoris* is one of the muscles most frequently paralyzed and is then the greatest hindrance to walking, because of flexion deformity of the knee. This should be prevented by a leather knee-cap attached to the upright of the brace.

In *gastrocnemius paralysis,* or even slight weakness of that muscle, the heels should be raised to prevent strain and stretching of the muscle by the superimposed body weight in walking. An elevation of the heel of a half to three-quarters of an inch in young children, and 1 to 1½ inches in older children, is necessary, while "bare foot" must be interdicted, even in undressing, and the use of sneakers and other heelless shoes absolutely forbidden, to avoid not only stretching of the gastrocnemius, but the production of permanent talipes calcaneus.

Objections to the use of apparatus are the extra weight and the muscular constriction caused by bands, lacings, etc., which hamper the already weakened muscles, but these objections are outweighed by the advantages gained. However, apparatus should not be worn except when actually required for walking, or to prevent deformity, and should be removed as often as possible.

The sense of equilibrium is often greatly impaired or lost by prolonged recumbency, and it is imperative to restore it before walking can be successfully accomplished. Loss of this sense must be reckoned with as a factor independent of the paralysis.

Patients with severe paralysis of the back, abdomen, and gluteal muscles require the support of a leather jacket with straps from the tops of the leg splints to the back of the jacket to act as substitutes for the gluteals and prevent flexion at the hips.

Fortunately the number of cases in which the loss of power consists only of muscular weakness, rather than of complete paralysis, comprise the vast majority of victims of the disease.

The active therapeutic measures of the convalescent stage aim at prevention of permanent deformity, and the restoration of nerve and muscle power. Massage, stretching of contracting muscles, and muscle training, are standbys in the therapeutics of this stage.

The *chronic stage* is marked by the cessation of spontaneous improvement. The lesions are stationary, and deformities and paralyses thoroughly established. When this stage has been reached, and the surgeon is truly convinced that a further return of muscle power is not possible, every case should be analyzed as to whether braces can be entirely eliminated, or can be diminished in their extent by some one of the operations above classified. This necessitates a very careful survey of the patient's musculature controlling each joint segment of the extremity, and consideration of the various operations which may be selected or designated to meet the particular conditions of the individual case. Meanwhile the full therapeutics of the convalescent stage are continued. It is at this chronic stage—about two years after onset—that the orthopedic surgeon many times sees these unfortunate patients for the first time.

The *examination* of such patients is important. First of all, the fear which so many children have of the doctor and the strange environment of his office, as well as their fear of pain during examination must be overcome. The surgeon must gain the confidence of his little patient, or the results of the examination will be valueless. In examining muscles, I have found it very helpful to designate their power by a scale of 0 to 4—4 indicating normal strength; 1, ¼ normal strength; and 0, nil, or complete paralysis. Taking the muscles of the foot for an example, we test the strength in flexion, extension, abduction, and adduction. If the plantar flexion is only one half normal, and the surgeon is confident that the child is applying all the force he can to that particular motion, he rates it as 2. The surgeon must make his own estimate, but comparison with normal muscles and normal joints on the opposite side aids materially in determining what constitutes "normal" strength for the individual in question. I repeat: examination should be delayed until the surgeon has the complete confidence of the child, in order that the muscle power may be estimated with accuracy.

I should like to speak here of the importance of muscles to joints—the whole usefulness of a joint depends on its proper control by the muscles attached. Further, it should be remembered that ligaments and capsules are weak and easily damaged in childhood. This is an important factor in treatment, for if these are properly supported until maturity, the joint will then stand a great deal of strain and abuse.

It will be evident from the foregoing discussion that *preventive treatment* is undertaken chiefly during the acute and convalescent stages of the disease. When the chronic stage is reached, we become concerned with *definitive* or *corrective treatment.*

Aside from the paralysis and the possibility of its surgical relief, the most important sequelae of the disease from the standpoint of the orthopedic surgeon are the deformities and contractures, and instability.

The question of the etiology of paralytic contractures has given rise to a multitude of theories and provoked keen controversy. In general, a contracture is due, not as is so often erroneously believed, to shortening of the paralyzed, but to overactivity of the healthy muscle group antagonistic in action to the paralyzed muscle group. "The normal position of a joint in the living body is determined and maintained by the equilibrium existing between the various muscles surrounding the joint—brought about by the elastic tension of the muscles and tendons—also by muscle tone" (Vulpius). Or, in other words, structural shortening occurs because, in the growing period of the child's life, the tonicity and elasticity of normally innervated muscles cause them to remain permanently in a shortened state in the absence (paralysis) of that stress normally brought to bear upon them by antagonistic normal muscle. This structural shortening is secondary to the contraction following unopposed muscle-pull. It should be noted that underlying all is the physiological property of soft tissue always to "take up slack" during the growing period.

Total paralysis of a limb is followed by relaxation of the joint capsule and a flail-like condition of the joints of the limb. If malposition of the limb is maintained for any length of time, shortening occurs in those enervated muscles whose points of

attachment have been approximated, and deformity of the limb accompanies these changes. The more extensive the paralysis the more severe the capsular relaxation, so that in children subluxation or even complete dislocation may occur.

Hypertrophy of the surviving muscles of a paralyzed limb almost universally occurs, and is a functional compensatory hypertrophy, e.*g.*, of the extensor longus hallucis for the paralyzed tibialis anticus; of the sartorius for the paralyzed quadriceps extensor femoris. Furthermore, compensatory hypertrophy occurs in the sound limb in unilateral paralysis, and the muscles of the arms are similarly affected in cases of paraplegia in which the arms are used as an aid in locomotion.

### Prevention of Permanent Deformity

Permanent deformity is nearly always preventable, and its existence is usually an indication of neglect or ill-advised treatment on the part of those having had charge of the patient, particularly in the case of deformities of the feet. Deformity resulting from paralysis of the spinal and shoulder muscles is, of course, a different matter, and permanent deformity may be unavoidable in such instances.

There are three stages in the development of deformity: (1) sustained malposition, which is remediable without the use of force; (2) lengthening of the soft parts on the stretched side of the joint, with shortening on the other side. In exceptional cases, the joint remains flail-like; (3) permanent structural bony and ligamentous deformity, due to adaptation of the growing bone to the vicious position. Gravity or weight-bearing may produce further deformity in a flaccid extremity. Unopposed muscle pull is also a factor.

### Operative Treatment

Operative treatment is designed to accomplish three purposes: (1) correction of fixed deformity, (2) stabilization, and (3) improvement of muscle function. Sometimes one operation will serve all purposes, but occasionally deformity is so serious that its entire correction must first be accomplished, and improvement of muscle function by transplantation deferred until a later operation. A transplanted muscle should never be required to

correct or maintain correction of a deformity. In fact, the anatomical architectural plans of the surgeon should be such, if possible, that the transferred muscle will function under more favorable mechanical conditions even than the muscle for which it was transplanted. This may involve stabilizing joints or changing relationship of bony skeleton by arthrodesis, silk or fascial ligaments, bone transplantation, etc.

The scope of this paper will not begin to allow detailed mention of all operations which can be approved of in the proper management of infantile paralysis. Therefore only the most striking, most recent, and those most far-reaching in their influence upon the return of function, or presenting peculiar technical difficulties will be discussed.

### Preparation of the Field of Operation

The patient should be admitted to the hospital at least 24 hours before the operation. Immediately upon admission a generous field of operation is shaved, and cleansed with benzine. Then a generous coat of 3½ per cent. tincture of iodine is applied, over which a sterile dressing is placed. Just before operation this is removed, and a second coat of 3½ per cent. tincture of iodine is applied. For children under two years of age, the tincture of iodine is diluted with an equal amount of alcohol, otherwise the preparation is the same.

After the patient is under anaesthesia, a tourniquet is applied if necessary, and a generous skin incision and approach to the field of operation made. Irritation of muscles or tendons by prolonged exposure to air is avoided by keeping them constantly moistened with saline solution.

### Operations

The following few operations, one for each joint segment, are chosen mainly to illustrate fundamentals, and no attempt has been made to cover all approved operative procedures for infantile paralysis, as time will not permit.

### Operations on the Foot

*Paralytic talipes valgus. Transplantation of peroneus longus and maintenance of correction of deformity by arthrodesis of the*

*astragalo-scaphoid joint.* One of the most troublesome cases from paralysis of one muscle is that of the anterior tibial developing into an extreme talipes valgus deformity. This is a most disabling one, owing to the weakness and distressing symptoms which follow in the foot.

Fortunately there is no weakness or distortion produced by infantile paralysis that is more satisfactorily relieved by surgical measures than this. And further there is nothing in the whole realm of orthopedic surgery which illustrates in a more pronounced way the necessity of devising and modifying operations to meet fully the mechanical defects present in the individual case.

Reasoning *a priori,* since the anterior tibial muscle is paralyzed or weakened, it might seem sufficient to the uninitiated merely to substitute the perineus longus, or the perineus longus and brevis, for the paralyzed anterior tibial muscle. But this is not the case, in that the very distortion following the weight bearing use of the foot with the tibialis anticus paralyzed is such that, when muscles are transplanted to take the place of the paralyzed one, they may tend to pull the foot into a more pronounced valgus rather than to correct the deformity. In other words, the distortion of the foot influences the direction of the pull to such a degree that, following the transplantation, it comes on the outside of the mechanical center of the midtarsal joints, rather than on the inside. It thus devolves upon the surgeon not only to correct, but to provide for the maintenance of the correction of the bony deformity at the same time that the muscle is transplanted. This can be done by the arthrodesis of the astragalo-scaphoid joint with the foot over corrected of its valgus and abduction. You will recall that the dorsal and plantar flexion of the foot and ankle comes almost wholly at the astragalo-tibial joint, and that here is very little lateral motion at this joint. On the other hand, the lateral motion of the midtarsal region of the foot comes almost wholly at the astragalo-scaphoid joint, and it is at the expense of this joint that the valgus deformity has occurred. Therefore, with the astragalo-tibial joint stable as to lateral motion, the arthrodesis of the astrogalo-scaphoid joint holds the forefoot stably corrected in the adductor position with the arch also corrected. Because of the already existing laxity

of this joint and its increase by the removal of the articulating cartilage from both bones at operation, it is wise in many instances to peg the two bones together with a bone graft, according to a method recommended by Ogilvy.

Mayer and Biesalski have made a worth-while contribution to orthopedic surgery by utilizing the tendon sheath of the paralyzed muscle as a physiological path for the transplanted tendon or tendons. Thus, in case of paralysis of the tibialis anticus muscle, the perineus longus tendon is drawn to its new point of insertion through the sheath of the paralyzed tendon. Their experiments prove that a tendon transplanted by this new technic glides in its new bed with the same freedom as a tendon normally does. In other words, post-operative adhesions are entirely avoided by this new procedure. In all other instances, the subcutaneous tissues should be sufficiently tunneled to receive the transplanted muscle readily, and in a perfectly straight line.

### Method of Inserting a Tendon

It is always preferable to transplant bone in the tendon end, and inlay this bone under trap doors of the periosteum and bone. If it is impossible to secure bone in the end of the transplanted tendon, the tendon end should be, whenever possible, anchored beneath bone. The transplantation of a tendon into a slit in another tendon is permissible, but not advisable, and should be avoided when possible. Bone tissue is specialized to withstand stress, and therefore when it is used to anchor tendons it proliferates under the influence of stress, precisely as it does when bony elements are actually coapted in a fracture or after a bone graft operation.

The tendon is anchored with No. 1 chromic catgut, or fine Kangaroo tendon. In some instances the transferred tendon may be sutured to the tendon it is functionally to replace, or some other tendon, and not seriously change its line of pull. These sutures may be absorbable and temporarily withstand all stress which might dislodge the tendon end from its implantation. Such is the case in the transplantation of the perineus longus or extensor proprius hallucis; the transplanted tendon is sutured firmly to the side of the anterior tibial tendon.

The fascia and soft parts are closed with O Chromic catgut continuous suture, and the skin is approximated by O catgut in continuous suture. *The line of suture* is then very carefully puddled with 3½ per cent. tincture of iodine until every suture hole and the line of incision is thoroughly impregnated. From a long study of wounds incased in plaster of Paris casts for many weeks immediately following operation, the speaker is thoroughly convinced that there is danger from latent bacteria in the deep layers of the skin, and therefore he has inaugurated this so-called puddling of the suture holes and the edge of the skin, so that a film of tincture of iodine will remain upon the skin edges as well as in the suture holes while the dressing is applied, prior to the application of the plaster of Paris splint. This technic has been employed upwards of ten years with the greatest satisfaction, in all skin wounds associated with bone graft operations, tendon transplantations, and wherever long continued plaster of Paris dressings are necessary.

The plaster splint is taken off 3 to 4 weeks after the tendon transplantation operation. Its removal is immediately followed by massage, muscle training, and temporary braceage. The latter is almost always necessary, and should be very much emphasized, as a recently transplanted tendon is very likely to become overfatigued if it is required to function in controlling a joint as well as in bearing weight. This is especially true in case of the foot. Of course it should be realized that in certain cases it may be necessary to apply some permanent bracage; in any event the amount should be much diminished as a result of the operative procedure.

Surgery of the infantile foot cannot be passed over without mention of the epoch making work of Whitman and Hoke.

### Operations on the Knee

In the event of the complete paralysis or near paralysis of the quadriceps group, with the hamstring tendons intact, transplantation of the biceps femoris muscle affords very favorable results: 1—because the knee joint is a hinge joint, having motion in one plane, and 2—because the origin, insertion, and length of the biceps femoris muscle are favorable to transplantation into the upper outer corner of the patella.

The fundamental considerations in all tendon and muscle transplantations is especially emphasized in this instance, in that the muscle, without traumatizing its surface, be carefully freed by sharp dissection sufficiently far up, so that when inserted into the patella, it will pull in the straightest line possible.

The transference of this muscle also illustrates the cerebral re-education and control of a muscle to function in an entirely different way. Instead of a pure flexor, it becomes a pure extensor of the knee joint. This fact was a mooted one with the profession for a number of years, but has now become most thoroughly established by extensive repetition of the tendon transplantation by a very large number of orthopedic surgeons. One point in technic is important—the tension upon the transplanted tendon and muscle should be zero when the origin and insertion of the muscle are separated.

### Operations Upon the Hip

*Paralytic dislocation of the hip.* For this most unfortunate condition an open operation is done which illustrates the great advantage of the plastic bone and joint technic. The hip is first reduced—this is easily accomplished. The acetabulum, the depth of which has been diminished by the wearing away of its rim as a result of friction from the constant slipping in and out of the head of the femur, is deepened artificially, as follows: The rim of the acetabulum is severed just outside and around attachment of capsule throughout its whole upper half circumference, then displaced outward, and a graft taken from just below the anterior superior spine of the ilium, is placed behind it. The capsule is then reefed with silk and medium Kangaroo sutures. This procedure deepens the acetabulum to beyond its normal depth. See Figures 1 and 2.

The Smith-Peterson approach to the hip is used.

A free exposure of the superior, anterior, and posterior portions of the capsule of the joint is given, together with its attachment to the acetabular rim; the posterior portion of the capsule is seen and felt to be lax, if the head is in the acetabulum, and if the head of the femur is disarticulated, it distends the capsule by pressure from beneath, and further displacement of the head is resisted. Upon manipulation of the femur, the head

is readily felt as a rounded hard surface, slipping about beneath the capsule.

The amount of deficiency of the acetabular rim can be very easily determined at this stage by direct parpation, and manipulation of the head. Above the capsular attachment of the acetabular rim, the bone surface is cleared of soft tissue, and with a narrow thin osteotome the bone is incised just outside of the insertion of the capsule in a semicircular line over the posterior-superior-anterior aspect of joint. This curved acetabular bone segment is then pried downward and outward with the osteotome to deepen the acetabulum. The prying downward and outward of this curved superior bony rim segment produces still more laxity and wrinkling of the attached portion of the capsular ligament. The slack is taken up by reefing this portion of the capsule by a row of mattress sutures of kangaroo tendon placed obliquely to the long axis of the neck of the femur. The stitches are so placed as to make the reef of the capsule lie equidistant from the two ends of the capsular bone insertions. This takes up the slack of the capsule, and at the same time helps to hold the new formed acetabular rim in position.

After the rim of the acetabulum has been depressed, one or two small wedge-shaped portions of the upper surface of the gap are removed with a sharp osteotome, and into these are inserted the bevelled ends of short bone grafts. The other ends of these grafts rest on the depressed portion of the acetabular rim, thus producing permanent overhanging of the latter. When such grafts have been inserted, the more pressure is exerted on the rim of the acetabulum from muscle spasm or weight-bearing, the more firmly are the grafts and the new rim of the acetabulum held in place.

*Arthrodesis of the hip.* In the event of flail joints or complete paralysis, two joints are most favorable to arthrodesis—the hip and the shoulder. In both joints, bone grafts are very advantageous in aiding to secure immediate arthrodesis. The type of technic is extremely essential in obtaining the desired results. Every surgeon must realize that the operation for arthrodesis, even in non-pathological joints, must be performed with meticulous care, both as to design and execution of the technic.

The speaker was the first to design an arthrodesis operation for the hip, and published this in the J. A. M. A. in June, 1908. This consisted of the careful morticing of the head of the femur into the acetabulum. It was found, however, after the extensive use of this operation, that there were about 10 per cent. delayed unions, and about 5 per cent. non-unions. Therefore the operation was modified by sliding a broad graft from the outer table of the ilium down in contact with the overlying outer surface of the neck of the femur, which was split to receive the lower end of the graft as an inlay. This graft in the adult is used for all arthrodesis operations of the hip joint, and is approximately 1½ inches wide and 2½ inches long. If this technic is properly followed, a bony ankylosis will be secured in at least 98 per cent. of cases.

A prominent orthopedic surgeon has recently stated that he personally is unable to get more than 50 per cent. of ankylosis from arthrodesis without a bone graft. This merely emphasizes the necessity for unfailing attention to design and technique in such operations—a point which I have already stressed. We must remember that we are working counter to Nature's powerful efforts to perpetuate or restore the natural function of a joint—*motion*.

In the case of a flail joint at the hip, an arthrodesis furnishes a very serviceable limb, and cannot be too highly praised. There is considerable motion of the pelvis in relation to the trunk, controlled by strong muscles, therefore a fusion at the hip with the femur in proper relation to the pelvis brings about not only very satisfactory motion by virtue of compensatory motion at the lumbar spine but may bring about as much as two inches of practical lengthening in a shorter limb from delayed growth.

### Operations on the Shoulder

At the shoulder, the same type of operation, with careful attention to the posture, gives even more brilliant results than at the hip, in that by arthrodesing the shoulder joint with the humerus anterior elevated and the hand in front of the face, while the scapula is flat against the thoracic wall, a very potent compensatory function is secured by virtue of the extensive range of motion of the scapula upon the thorax. If the scapula-

thoracic muscles are intact, the function following such an operation is very surprising to patient and family, providing the muscles controlling the elbow and hand are also intact. For the helpless flail extremity, hanging limp from the shoulder, is transformed into one that is very satisfactorily controlled by the powerful scapulo-thoracic muscles.

The *technic* of arthrodesis in this joint I believe to be even more important than in the hip joint. "Beginning just internal to the acromioclavicular joint, a vertical incision is made downward to the outer side of the pectorodeltoid groove. The capsule is incised along the bicipital groove, and the synovia excised as thoroughly as possible, and any remaining is curetted away. Dislocate the head from the glenoid by sharp external rotation of the humerus. All cartilage is removed from the head and glenoid by osteotome or gouge, and from the approximating surface of the acromion process. While the scapula is held in good position by an assistant, return the head to the glenoid cavity and in close contact with the acromion process. With the arm held in slight internal rotation, elevated anteriorly at right angles to the body, and slight flexion at the shoulder (in such a position that by flexing the forearm the patient can touch mouth, head and neck), a bone graft peg is driven into the head of the humerus, through the acromion process. This latter procedure retains the position, increases fixation, and hastens bony union. The capsule is reefed to take up the slack and improve immediate immobilization. The arm and shoulder are fixed in the desired position in plaster of Paris, which immobilization is maintained for at least ten weeks."

This technic was first described by the speaker in a monograph entitled "Bone Graft Surgery," in 1917.

In controlling the patient during this operation upon the shoulder and also the arthrodesis upon the hip, it is almost imperative that the surgeon have the benefit of the Albee fracture orthopedic operating table, in order to control the posture of the extremity and the trunk during the operation, and during the post-operative immobilization by plaster of Paris splintage. (The Albee table is specified because there is no other which allows the upper extremity to be held in such postures during and after operation.)

I believe there is no more unfortunate deformity following infantile paralysis than the extreme case of paralytic scoliosis, and no condition is more unfavorable to treatment by conservative braceage. The spine takes the letter S curve. Both the thorax and the abdominal viscera are compressed, and discomfort and pain are caused in the more severe cases by the impingement of the lower ribs, as they telescope inside the pelvis.

In all cases of scoliosis we find primary and compensatory curves. The correction of the primary curve has a very material and direct corrective influence upon its compensatory curves. Therefore, in the case of paralytic scoliosis, correction of distortion and ankylosis by graft or fusion of the vertebrae, which make up most or all of the primary curve, has a very potent influence in diminishing the compensatory curves.

Here again plastic surgery has enabled the surgeon to do what was hitherto impossible for these most unfortunate cases. The bone graft is put in in a manner slightly different from that used in the speaker's operation for cases of anterior-posterior kyphoses, such as those observed in Pott's disease. In cases of paralytic scoliosis, the same mechanical principle is applied, but the graft is so placed that the deforming influence which acts laterally comes upon the graft edgewise. In other words, speaking figuratively, the graft is inserted into the spinous processes flatwise.

The following case is most illustrative of what can be done for these unfortunates by means of plastic bone surgery.

The patient, a man aged 20, as a result of infantile paralysis had a marked scoliosis of the type just described, with telescoping of the ribs, and also complete paralysis of the right quadriceps group of the right leg. It was thought that operative intervention had a much better chance of success by transplanting the right biceps forward for the quadriceps group, and therefore he was admitted to the Post Graduate Hospital, and the operation carried out as we have already described under transplantation operations.

A year later the patient returned to me, and was so much pleased with the improved function in his right leg following

the operation, that he begged to have his spine operated upon. Therefore he was again admitted to Post Graduate Hospital, and was placed in the dorsal position upon a gas-pipe frame especially designed for him, and lateral corrective tension applied constantly for a period of two weeks. This constant stretching straightened the spine very materially, and the author's regular operation for Pott's disease was then done, with the variation in the placement of the graft already referred to. In other words, the spinous processes of the lower dorsal and lumbar vertebrae were split, and a graft inserted flatwise into these processes, using the graft as a lever to still further increase the correction of the scoliotic deformity. Fig. 3.

It was then found that, because of the extreme amount of lateral deviation at the lumbosacral junction, the floating ribs were still riding at about the level of the iliac crest; and fearful that relief from the pain of the telescoping of the ribs would not be complete, it was decided to put in a graft as a prop between the rim of the pelvis and the anterior end of the 10th rib.

A longitudinal incision through the skin and subcutaneous tissue was made from about 1½ inches back of the anterior end of the 10th rib, directly downward to the crest of the ilium. The ribs were then by strenuous lateral tension forced above the crest of the ilium as far as possible. A measure was then taken of the distance between the rim of the pelvis and the rib; this was found to be about 6 inches. The rib was mortised as well as the ilium, to receive the tibial graft properly. The wound was packed with hot saline, and the anterior internal surface of the right tibia was exposed for a distance of about 8 inches. A graft 6 inches long and ½ inch wide was removed by means of the twin motor saw, and the central portion of the anterior internal surface, including the complete thickness of the cortex of the bone with its periosteum, and as much marrow as would cling thereto. The ends of the graft were then notched by removing a triangular piece of bone from each end. The pack was removed from the olio-thoracic wound, and by means of elevating the ribs as far as possible from the crest of the ilium, the notched ends of the graft were inserted into the mortices already prepared for it. These ends were firmly held in place by sutures of medium Kangaroo tendon placed in the bones and

the periosseous structures at either end. Both wounds were closed in the usual way.

With the patient still in the ventral position on the Albee Fracture-Orthopedic operating table, a plaster of Paris jacket was applied from the base of the skull and well under the arms to below the crest of the ilium. This was specially molded during the hardening period, so that it acted as an overcorrecting influence on the lateral deformity of the trunk.

The patient made an uneventful recovery, and has been one of the most successful cases I have ever had the privilege to operate upon. This operation was done in January, 1923, so that I can speak with confidence of the results.

I have purposely said very little about muscle training, for this is a subject meriting a paper by itself. It is one of the great assets in the armamentarium of the orthopedic surgeon, both preoperatively and postoperatively, as well as in cases in which operation is not indicated. Muscles that have been weakened or have been temporarily paralyzed, with subsequent return of power are in many instances not properly controlled, and the child is unable to contract them fully at will. This emphasizes the necessity for muscle training in all cases. There is one striking difference between pre- and post-operative muscle training: the former develops individual muscle power; the latter educates the brain to make the transplanted muscle function in an entirely different way.

I should like to leave you with a picture of nearly 600 muscles with all types and variations of paralysis and weakening, reflecting a corresponding variety of distortions on the skeleton; for extremity and trunk postures are wholly dependent upon muscle balance. It is evident, with such a picture in mind, that the braceage, muscle training, and operative management of infantile pralaysis cannot be stereotyped. No two cases are alike, and the orthopedic surgeon must not only be a good technician, but a mechanical genius, ready at a moment to devise mechanical apparatus or reconstruction operations as called for by the conditions in the individual case.

## OPENING OF THE NEW BUILDING

Progress on the new building continues satisfactorily and it is confidently expected that it will be ready for occupancy in October.

The moving of the Library began early in August and should be completed the first week in September, but the Library will not be in running order until the opening of the new building. The Council regrets deeply the closing of the Library over so long a period but it is unavoidable.

### Opening Ceremonies

The new building will be formally opened on Tuesday afternoon, October 19, when there will be several addresses and inspection of the building by the Fellows and their friends followed by a reception.

It is planned to have a dinner at the Hotel Commodore on the same evening in honor of the newly elected Honorary Fellows, many of whom will be present. Special notices of this dinner will be sent to the Fellows the last of September. On Thursday evening, October 21, the first stated meeting will be held in the new building.

Papers will be read by Professor Charles James Martin, of Cambridge, England, and Professor Friedrich Müller, of Munich.

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# THE COMMITTEE ON PUBLIC HEALTH RELATIONS

## SUMMARY REPORT ON SEGREGATED CLASSES FOR CARDIAC CHILDREN IN THE PUBLIC SCHOOLS

### 1. The Problem of the School Child With Heart Disease

According to the findings of school medical inspection in this city, 14 out of every 1,000 school children suffer from some kind of heart defect. A more complete clinical examination of a large number of school children established the incidence of actual organic heart disease to be about 7 in 1,000 in the elementary schools of New York City.

The classification of cardiac children adopted by the New York Heart Association is based on the functional ability of the heart to withstand the physical strains of every day tasks. In addition to the groups designated as having possible and potential heart disease, there are three classes of organic heart defects: those in Class I have practically normal physical capacity; Class IIA comprise those which have only slightly diminished physical capacity; Class IIB with very little cardiac reserve power; and Class III with no reserve. Class IIB and III children all have some degree of heart failure, but the determining causes of heart failure in adults and children are in the vast majority of cases entirely different. Heart failure in adults is the result of dynamic changes in the circulation. In children acute infection, usually rheumatic, involving the endocardium and the myocardium, and at times the pericardium, accompanies and is the exciting cause of the heart failure. With subsidence of the underlying infectious process, the child passes through a period of convalescence to almost perfect compensation, graduating into Class IIA and even to Class I where he is able to carry on the ordinary activities of childhood.

At times children apparently in Class IIA have a mild but nevertheless actively infectious heart disease which may escape detection for the time being because there is little evidence of their reduced ability to perform work. All these children with active heart disease are sick children and should be in bed, no matter what their physical ability to perform work.

Children who have had active heart disease within a period of several months to a year, or even more, are likely subjects for a reinfection or recrudescence of a smouldering infection. In addition, children with potential heart disease may at any time develop active heart disease.

Numerically, Class I comprises the largest group of cardiopathic children (55 per cent.). Class IIA includes 37 per cent. of the children, Class IIB, 7 per cent., and Class III, 1 per cent. There is a small group of cases which are designated as borderline cases between Class IIA and Class IIB. The children in this group do not fit definitely into either classification. The majority of these children, by removal of focal infections, by attention to nutritional disturbances, by residence for several weeks in cardiac homes in the country, improve steadily and can be placed very definitely in Class IIA. The minority becomes worse, being placed in Class IIB and Class III, requiring bed treatment. There is a small remainder, about 3 per cent. of all cardiac children, who remain *in statu quo*.

### 2. Need of Adequate Medical Supervision

It is because of the peculiar character of heart disease in children that expert medical supervision is required. There is need of watching over these children continuously with a view of prescribing exercise and re-classification. The children must be followed up in their homes with a view of educating the parents to the importance of enforcing the prescribed routine.

The segregation of cardiopathic children in special classes as has been done by the Department of Education of this city has been found unsatisfactory by the New York Heart Association. The Association pointed out that:

(*a*) With a slight change in the daily routine of cardiopathic children, there is no need of segregation of children classified as I and IIA, and children in Class IIB and Class III are too sick to attend school; and

(*b*) The small number of children in the borderline group requiring rest periods or special lunches could be accommodated in the existing classes for handicapped children.

Because of the existing difference of opinion between the Heart Association, on one hand, and some members of the admin-

istrative staff of the Department of Education and certain clinic physicians, on the other, the Committee on Public Health Relations was asked by the Superintendent of Schools to submit conclusions and recommendations concerning the problem.

### 3. Conclusions of the Inquiry Made by the Committee on Public Health Relations

After conferences with every one concerned in the matter, the Committee on Public Health Relations came to the following conclusions with regard to the problem:

(*a*) That the expansion of the segregated classes on the part of the Department of Education has not been warranted during the period of the demonstration and particularly since the report of the demonstration has been submitted;

(*b*) That those responsible for the segregated classes in the Board of Education evidently do not appreciate that segregated classes *per se* are not the aim but afford a method of medical control and supervision. They are satisfied that what is needed is not strict medical supervision but merely medical advice, and their chief interest lies quite naturally more in the educational than in the health problem;

(*c*) That segregated classes under strict medical supervision have certain administrative and perhaps educational advantages, but in view of the best medical evidence they are of no value to the children insofar as the cardiac condition is concerned;

(*d*) That only a small number of existing segregated classes have adequate medical supervision, including the nursing and follow-up service indispensable to the supervision of children and the education of parents;

(*e*) That the selection of children is adequate in schools which are properly supervised from the medical point of view. In the other classes, the selection has been on a haphazard basis;

(*f*) That the immediate discontinuance of all the unsupervised segregated classes would be desirable; and

(*g*) That the plan of supervision by the Bureau of Child Hygiene of the Department of Health as recommended by the Heart Association is a practical measure, and if adequately carried out would afford a supervisory service for all children with cardiac defects allowed to attend school.

### 4. Recommendations

In view of the above conclusions, the Public Health Relations Committee recommends:

(*a*) That all segregated classes for cardiac children be eventually discontinued and that any children needing special care, *i.e.*, the so-called borderline cases between groups IIA and IIB, being about 3 per cent. of all cardiac children, be placed in the special classes for handicapped children. Pending the establishment of an adequate policy of medical supervision to be worked out by the Health Department in cooperation with the Heart Committee of the New York Tuberculosis and Health Association, formerly the New York Heart Association, no new classes should be established;

(*b*) That all the segregated classes which at present have no proper medical supervision should be discontinued and no attempt made to assemble them at the beginning of the next school term. Only such classes as are approved by the above mentioned Heart Committee as having adequate supervision might be continued until such time as the other method of supervision suggested by the Heart Association should have been fully and satisfactorily developed. These classes could also be utilized for further experimental work in the medical and pedagogical aspects presented by certain types of cardiopathic children who are considered able to attend school;

(*c*) That the attention of the Department of Health should be called to the prevalence of heart defects among pre-school children with a view of having special emphasis placed on the heart examination of the children entering public schools and the supervision of the cardiopathic children begun as early as possible; and

(*d*) If the transportation facilities be available, borderline cases between IIA and IIB which are considered able to go to school should at the discretion of the supervising medical officer be placed either in the medically supervised segregated cardiac classes where these still exist or in other existing special classes.

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